



James Webb Space Telescope Optical Telescope Element (OTE) Mirror Coatings

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Outline



- Introduction
- Coating Qualification Program
- Flight Mirrors



JWST Optical Telescope Element (OTE) Mirrors



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Ball **ITT EXELIS**



Primary Mirror Segment



Secondary Mirror



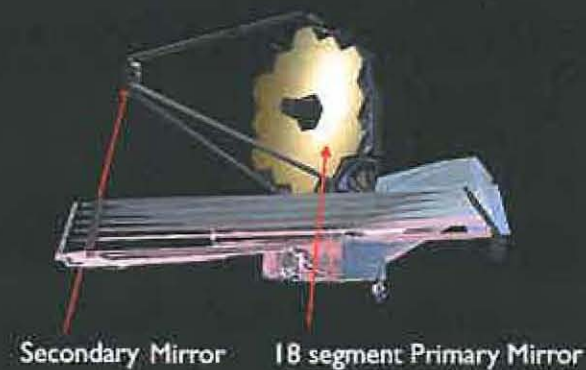
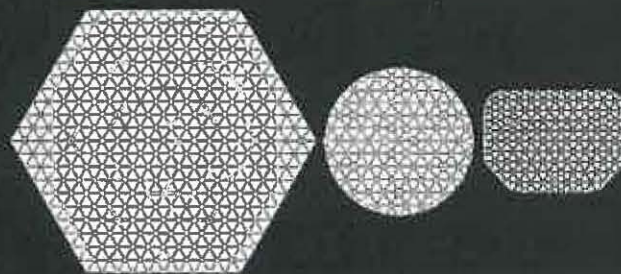
Tertiary Mirror



Fine Steering Mirror



Rear side view of mirrors showing relative size



Secondary Mirror

18 segment Primary Mirror



JWST OTE Mirror Sizes



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ATK

Mirror	Size	Figure
Primary Mirror	6.5 m aperture f/1.2	Elliptical
PM Segments	1.52 m point to point	
Secondary Mirror	0.738 m diameter	Hyperbolic
Tertiary Mirror	0.513 m x 0.709 m	Elliptical
Fine Steering Mirror	0.17 m diameter	Flat



Reflectance Requirements



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Wavelength (μm)	Reflectance Requirements (%)
0.8	≥ 94.1
1.0	≥ 96.3
1.5	≥ 97.4
2.0 -20.0	≥ 97.9
20.1 – 27.0	≥ 97.9
27.1 – 29.0 (Goal)	≥ 97.9



Coating Qualification Program



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- Reflectance
- Uniformity
- Run to run thickness variation
- Micro roughness
- Durability
- Maintainability
- Coating stress
- Scratch/dig
- Pinholes.

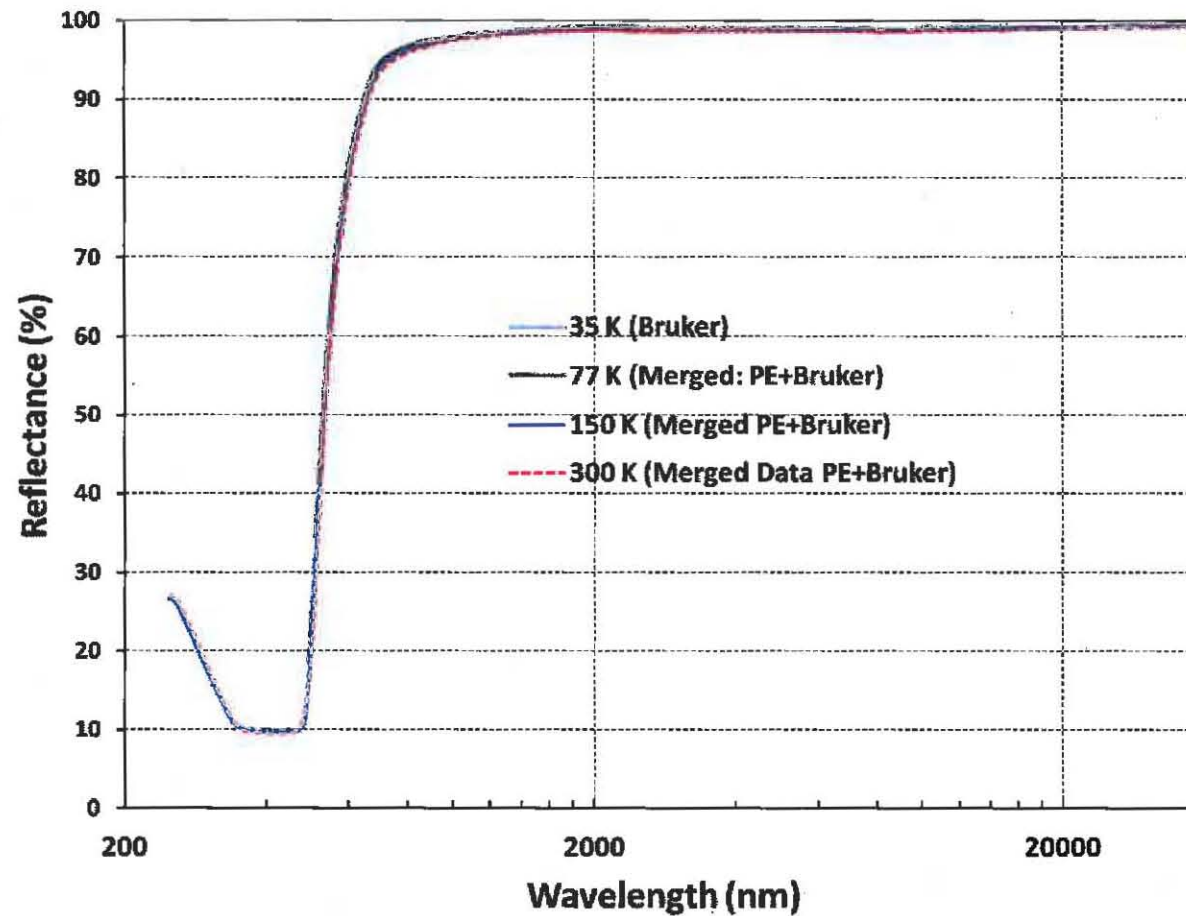


Coating Reflectance at Temperatures from 300K to 35K



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Radiation Exposure



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Proton Beam Energy: 3.0KeV
Electron Beam Energy: 10KeV

Exposure Rates for JWST OTE Gold-Coated Test Samples

	First Exposure time length (sec) 2.38E+05	2nd Exposure time length (sec) 2.56E+05	3rd Exposure time length (sec) 2.55E+05	4th Exposure time length (sec) 2.62E+05	
sample	p/cm ² s	p/cm ² s	p/cm ² s	p/cm ² s	e/cm ² s
G3	2.97E+09	3.60E+09	3.33E+09	2.21E+09	2.30E+09
G4	2.84E+09	3.50E+09	3.17E+09	2.29E+09	3.07E+09
G6	2.98E+09	3.55E+09	3.29E+09	2.29E+09	2.55E+09
G7	3.11E+09	3.67E+09	3.45E+09	2.18E+09	1.81E+09

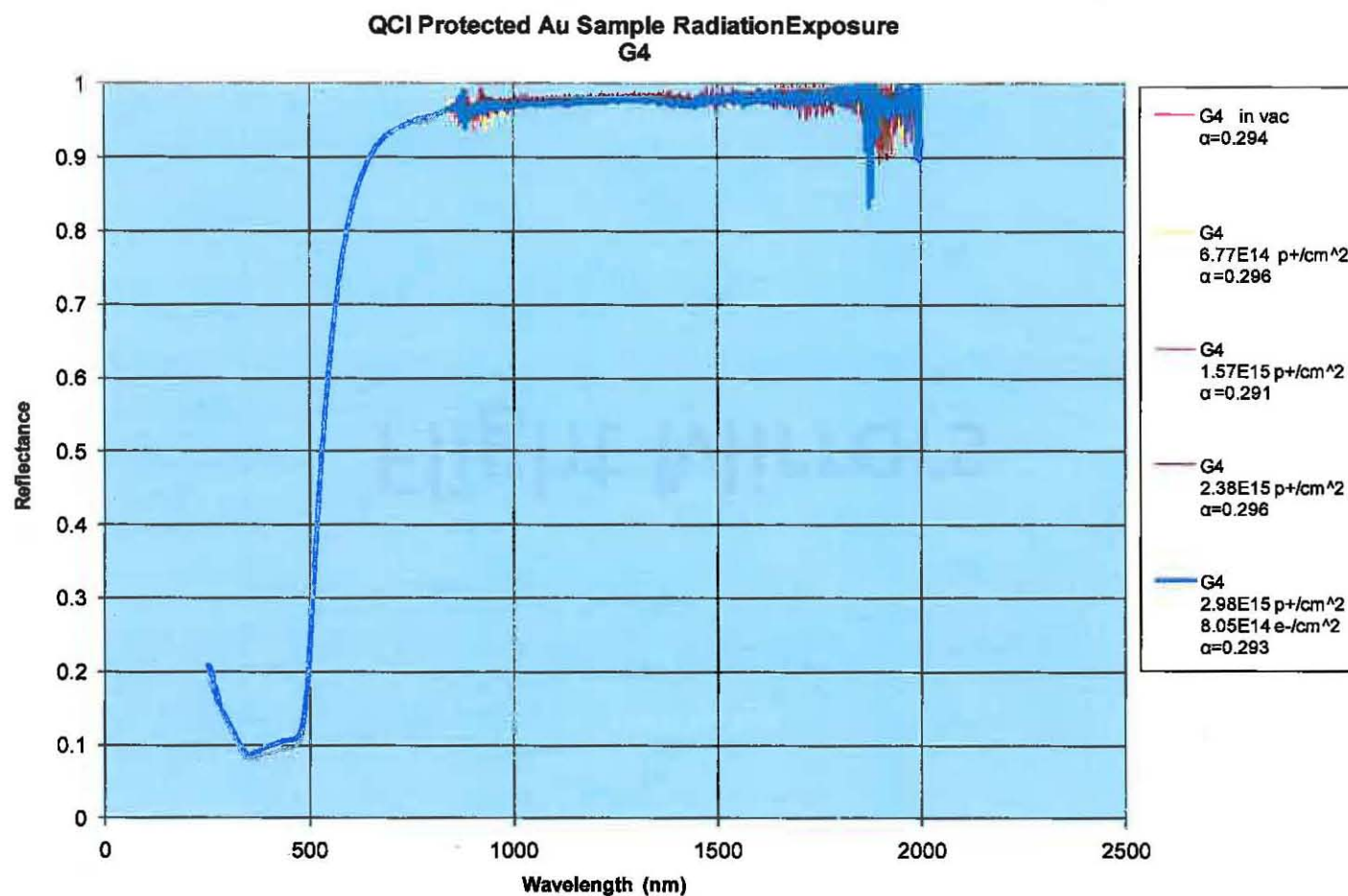


Reflectance of QCI sample G4



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Exposed to $2.98E15$ protons/ cm^2 at 3keV plus $8.05E14$ electrons/ cm^2 at 10keV



Flight Mirrors



Tertiary Mirror



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The Engineering Development Unit (EDU) primary mirror segment

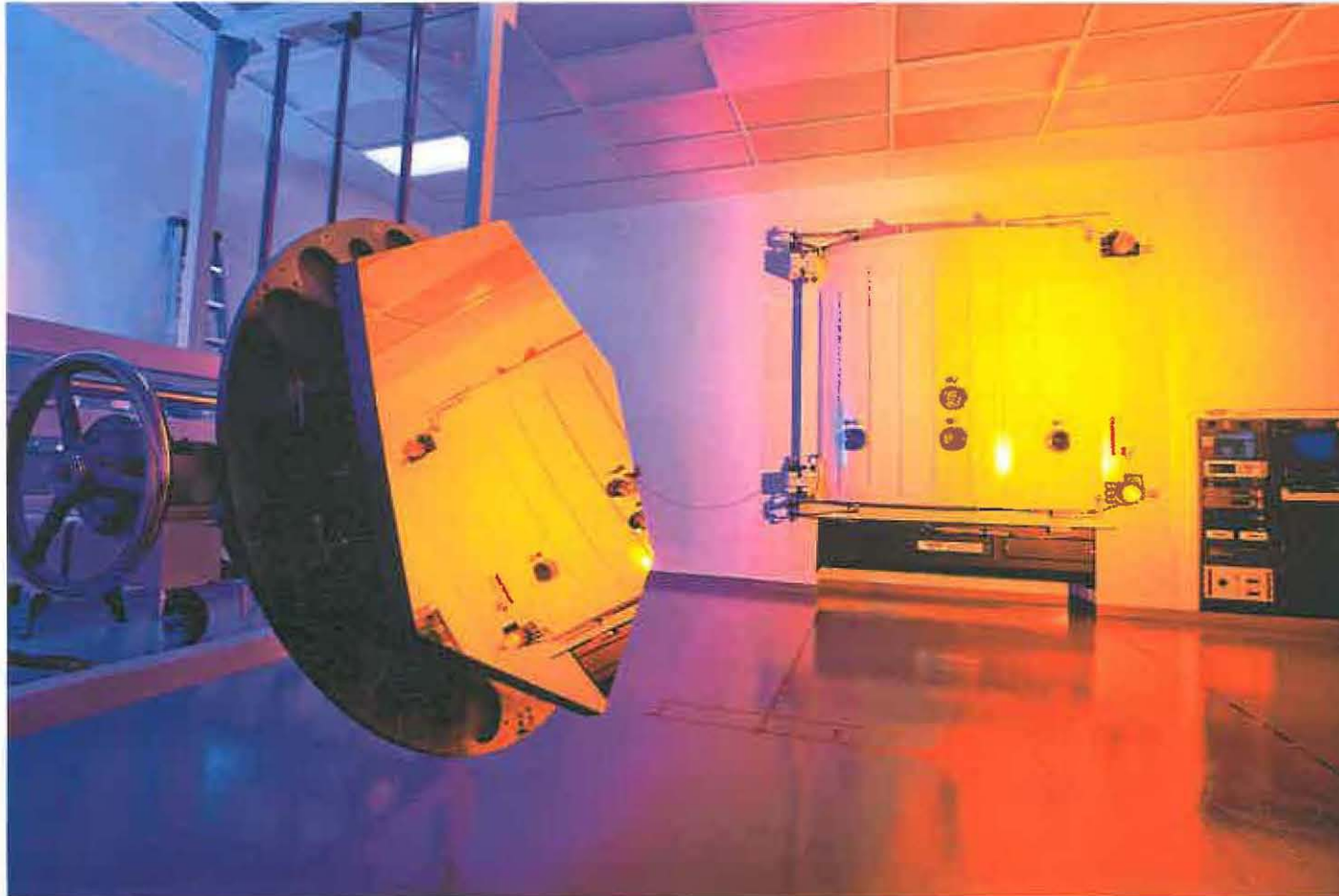


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Coated in gold by Quantum Coating Incorporated



Primary Mirror Segment Assembly B6



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PMSA B6 in the coating fixture and being readied for shipment to BATC.



Primary Mirror Segment Assembly C3



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PMSA C3 in the coating fixture with the mask on, the mask removed (top pictures) and being readied for shipment to BATC.



PMSA A1 Reflectance Results



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Wavelength (μm)	Reflectance Requirement(%)	Measured Reflectance (%)
0.8	≥ 94.1	96.0
1.0	≥ 96.3	97.3
1.5	≥ 97.4	98.0
2.0 -20.0	≥ 97.9	98.5 – 98.8
20.1 – 27.0	≥ 97.9	99.08 – 99.42
27.1 – 29.0 (Goal)	≥ 97.9	99.16 – 99.35



Secondary Mirror



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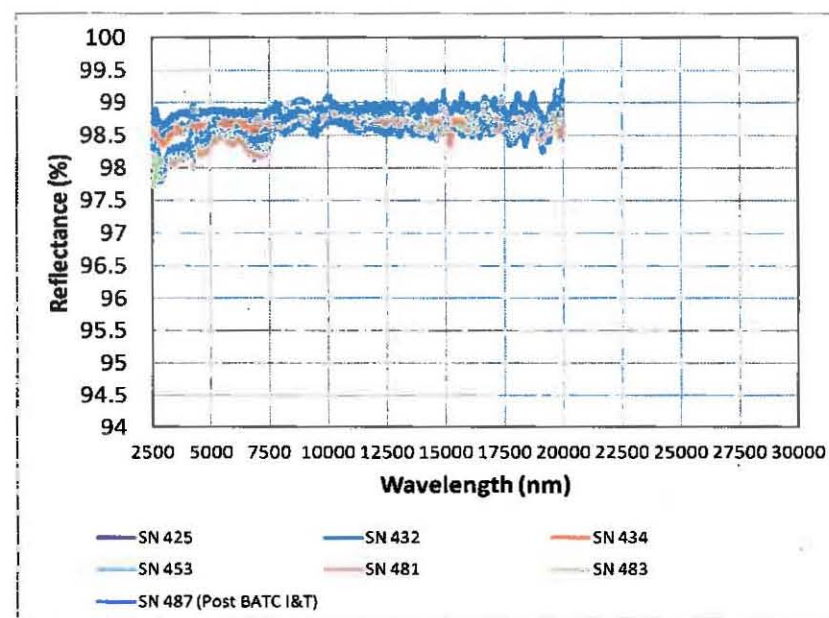
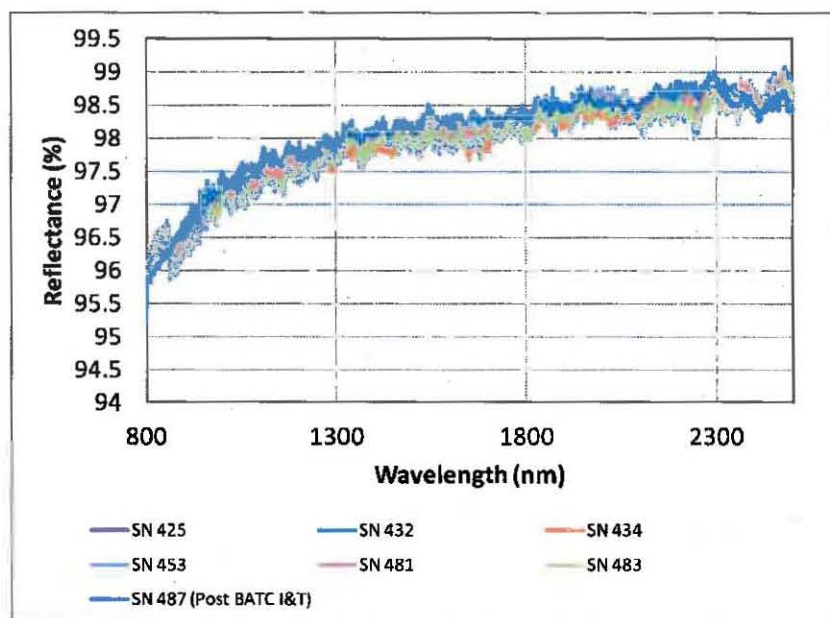


PMISA A1 Run Reflectance



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Post BATC I&T Sample compared to 6 QCI Acceptance Samples.

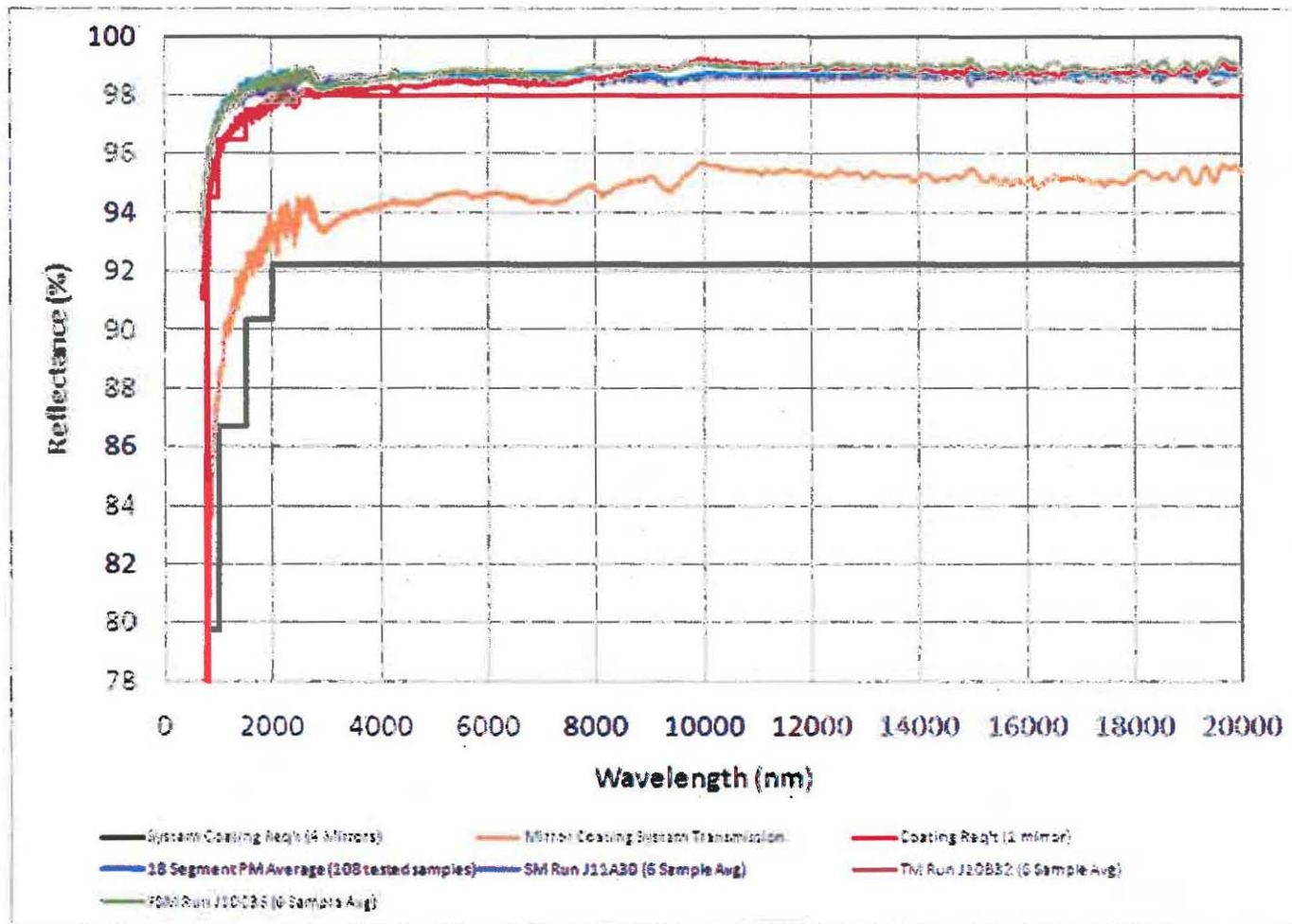


Reflectivity of the JWST Mirrors and the Throughput of the Telescope.



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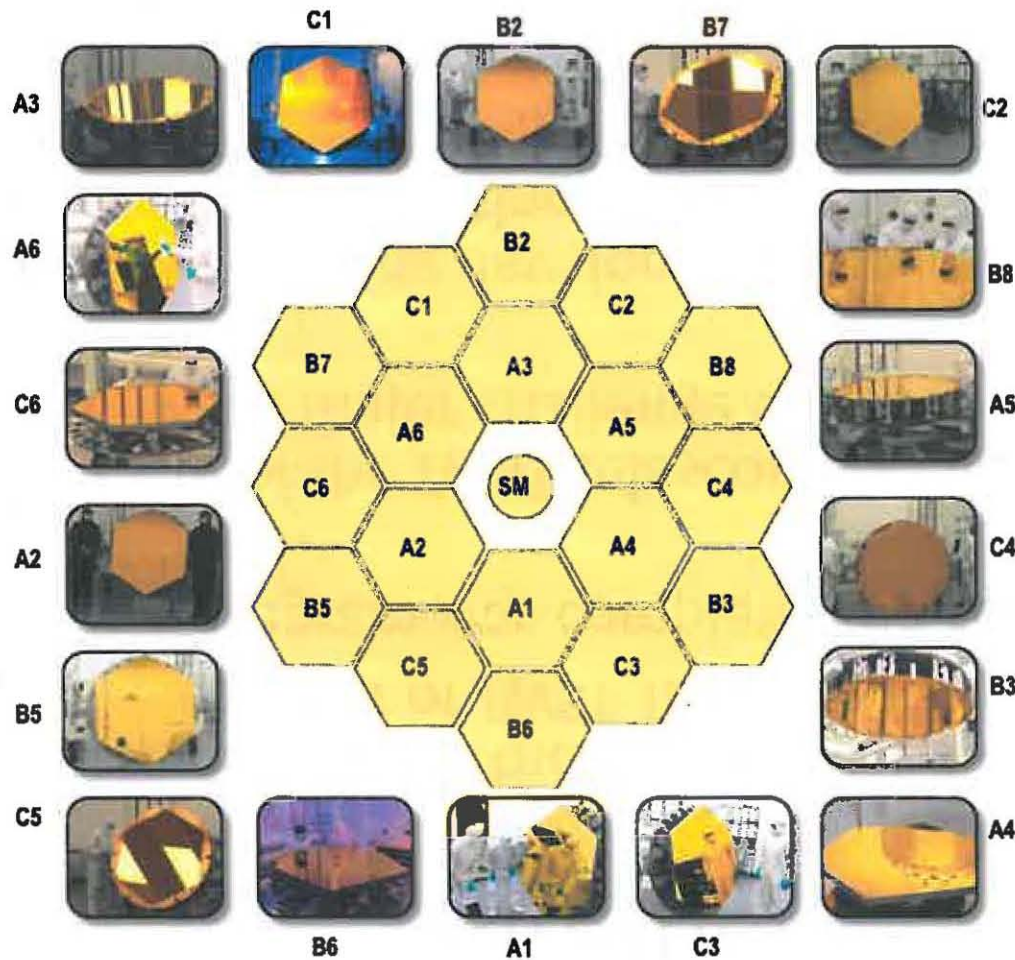


JWST Telescope Mirrors



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Secondary



Tertiary



Fine Steering



Summary



- Completion of coating the mirrors was a major milestone in the development of JWST Telescope.
- The coating program was completed on schedule with excellent results.
- The large size of the JWST telescope primary mirror segments was a major challenge that was overcome successfully.
- The extensive coating development program over a two year period before coating was key to the successful program.
- Success ensures the scientific discovery potential of James Webb Space Telescope.